# Notes on the Winter Epiphragm of *Pupoides albilabris*

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(1 Text figure)

## INTRODUCTION

During dormancy pulmonate land snails typically occlude the aperture of the shell with one or more secreted partitions known as epiphragms (Rokitka & Herreid, 1975). Although thin epiphragms are not highly impermeable (Machin, 1968; Picher, 1972), the reduction of gas exchange across thick or multiple epiphragms can apparently be severe enough to require special provision for respiration. Many helicid epiphragms exhibit a distinct white patch or "Kalkfleck" opposite the pneumostome which may be an area of increased permeability (Picher, *op. cit.*). Certain other pulmonates form well-defined slits or holes in each epiphragm (Hora, 1928; Rees, 1964). This report describes the perforated winter epiphragm of *Pupoides albilabris* (C. B. Adams, 1841), a small land snail of the family Pupillidae. The observations refer to specimens collected from beneath stones and plant debris on a sparsely wooded slope in Lawrence, Douglas County, Kansas.

## OBSERVATIONS

Winter-collected specimens possess a thick, brown hibernation epiphragm, very different from the thin, transparent film which is formed in other seasons. The epiphragm is remarkably tough yet flexible; treatment with acid indicates that it is not calcified.

The central portion of the hibernation epiphragm adheres to the surface beneath which the snail is sheltered. When detached from the substrate, the epiphragm remains intact in the aperture and the formerly attached portion is distinguishable by texture (stippled area of Figure 1A). Surrounding this central area is a narrow border unattached to the substrate. At the upper, outer margin of the aperture the border includes a well-formed oval perforation. In 5 specimens, the mean dimensions of the pore were 190 $\mu$ (161 - 219) by 104 $\mu$m (88 - 117).

The inner surface of the hibernation epiphragm was examined after breaking away part of the first whorl of the shell behind the aperture (Figure 1B). The outer epiphragm is backed by a layer of very thin cells or bubbles of epiphragmal substance, which extends across the entire aperture. This secondary barrier is not perforated.

## DISCUSSION

The classical view of the epiphragm as a hermetic seal preventing water loss (Binney & Bland, 1869) is incorrect, as it is now known that water vapor diffuses fairly rapidly across intact epiphragms. The mantle collar tissue is the primary barrier to evaporation from the aperture and the vapor pressure gradient across the epiphragm itself is probably very low during dormancy (Machin, 1968). However, epiphragms are vital in water conservation since they protect the sensitive mantle collar and pneumostome from disturbance by small arthropods or wind-blown debris. Such disturbances would greatly increase mucus secretion and evaporative water loss (Nopp, 1974). The protective function could be especially im-

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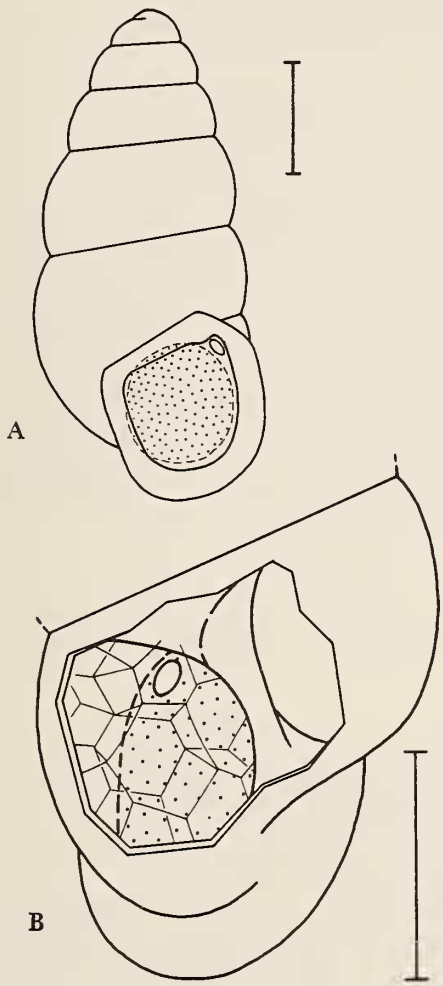
Figure 1

A. Dormant individual with perforate hibernation epiphragm. Stippled area is attached to the substrate *in situ*. B. View through first whorl behind aperture, showing layer of epiphragmal bubbles. Scale lines = 1 mm




portant during the long periods of unfavorable conditions experienced by temperate species during winter. Supercooling may be an important mechanism of freeze-resistance in hibernating land snails (Riddle, personal communication) and contact of ice crystals or debris with the supercooled tissue might induce nucleation and freezing.

The thickened winter epiphragm of *Pupoides albilabris,* together with the habit of attachment during dormancy, provides excellent mechanical protection for the animal during hibernation. The outer barrier is not complete, however, presumably because respiration requires the presence of a pore. The imperforate secondary layer of bubbles completes the closure of the aperture, and, protected by the outer epiphragm, can be thin enough to allow diffusion of respiratory gases.

It is interesting to note that other pupillid species examined (*Gastrocopta armifera, G. contracta, G. procera*) did not form a thick hibernation epiphragm. In these species the aperture is protected by large lamellae which are lacking in *Pupoides.* A layer of thin epiphragmal bubbles, like that in *Pupoides,* was found at and behind the lamellae.

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